

HIGH-VELOCITY CRACKING OF LIQUID HYDROCARBONS

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High-velocity cracking represents the decomposition of hydrocarbons under such conditions that there is a rapid rate of external heat exchange combined with a short time of reaction at high temperatures. Let us examine some of the characteristics of cracking at high temperatures. In the first place, as thermal cracking are sharply increased. We will clarify what changes this will bring about aside from generally intensifying the process. The first stage of constst of destruction with the formation of saturated and unsaturated compounds having a shorter hydrocarbon chain, and condensation reactions of compounds obtained as a result of the destruction. In other words, the process of the (i.e., of coke) from crude oil during cracking can be interpreted fundamentally products [1].

It is known that the maximum yield of the intermediate products depends on the ratios of the individual reaction velocities, i.e., in this case on the reaction of the velocity of the destruction reaction to that of the coke-forming carbons [2] and of heavy oils with short contact durations, under the conditions of rapid heat exchange, and also on the basis of published data [3, 4], takes place at a slower rate than the destruction reaction. Since the rate of the first process (coke formation) increases with increasing temperature relavated temperatures (see also [8]). From the kinetic point of view, this is process that forms a new solid phase, requires multiple collisions and has a comparatively low activation energy.

Analysis of our experiments and those described in the literature [3, 4] indicates, in agreement with what has been stated, that as the temperature is ing with a degree of conversion that is not too high, not only does not ircrease, but even decreases. Thus, by selecting a sufficiently short reaction time and crease the rate of thermal cracking without increasing the yield of coke. Of the other characteristics of the chemistry of cracking at high temperatures, fraction of unsaturated and aromatic compounds in the cracking products increases as a result of displacement of the equilibria involved.

The study of cracking at high temperatures is closely tied in with the problem of achieving a rapid transfer of considerable quantities of heat into the zone of the reaction for rapid heating of the products being cracked. It contact with particles of a heat carrier, i.e., by external heat by direct Rapid heating by using particles of a heat carrier also has its limits of applicability however. It obviously cannot be used with temperatures and process of the reaction. Until now no one has examined this problem specifically and inasmuch as the disregard of this circumstance lowers the value of a number of



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other works, we will examine this question in the light of its bearing on the applicability of high-velocity cracking. With this aim in view, we will estimate the minimum time required for heating in rapid cracking by using the theory

Let us assume that the amount of the previously heated stationary heat carrier (particles having an effective diameter d) is many times greater by weight than the amount of the product to be heated. Let us assume that the product, after first being heated in the conventional way to the temperature To, at which the reaction proceeds sufficiently slowly, is required to be heated rapidly to 200-300 degrees. We will assume that the heat-transfer coefficients for the product to be cracked will be equal to some value

$$D = \frac{\lambda}{c\rho} = \gamma = a$$

corresponding to an average temperature where λ is the coefficient of heat conductivity, λ the coefficient of kinematic viscosity, ρ the density, and C the specific heat capacity at constant pressure.

On the basis of Z. F. Chukhanov's formula [9], and neglecting heat transfer by radiation, we find that the coefficient of heat transfer is equal to:

$$\alpha = \frac{\text{Number}}{d} = 0.24 \frac{\text{Re}}{d} (\text{Re})^{0.83} (\text{Re} > 100),$$
(1)

or

Γ

where \boldsymbol{V} is the linear velocity of flow around the particles. Since we stipulated that the amount of heat carrier will be many times greater than that of the product to be heated, we can neglect changes in the temperature of the heat carrier T_{t} while estimating the heating time. In this case

$$c \frac{d(T - T_t)}{dt} = \propto s (T - T_t)$$
(3)

where S is the surface of the heat carrier as compared to the unit mass of the product being heated. Integrating (3) and taking as the time of heating the time Θ in which the difference T - T_t decreases by the factor of e, we find

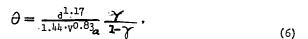
$$\Theta = \frac{c}{\alpha s} = \frac{1}{0.24 s_{\text{ps}} 0.83} \left(\frac{d}{\alpha}\right)^{0.17}$$
(4)

With the aid of simple considerations we find that

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 $S = \frac{6}{d\rho} \frac{1 - \gamma}{\gamma} \tag{5}$

(where $m{\gamma}$ is the degree of dispersion). From this we obtain a formula for the heating time:



Formula (6) holds when Re is greater than 100 and under such conditions that the ratio of the weight of the heat carrier to the weight of the heated product is greater than one. The expression for the heating time (6) depends teristic for processes having a well-developed turbulence. In the case under consideration, a 0.17 is always equal to 1 (cm7 'sec), hence the heating time is practically independent of the properties and the rate of flow and when Re is less than 100, formula (6) ceases to be correct. Instead, when Re is less than 10 and Nu is constant and equal to 2, another expression is obtained

$$\Theta = \frac{d^2}{12a} \frac{1-Y}{Y}.$$
 (7)

When Re is greater than 10 but less than 100, one can interpolate between formulas (6) and (7). The expressions for the heating time, (6) and (7), indicate that under the conditions of rapid cracking, Θ has a value of the order of 10-4 seconds.

Of special interest is the rapid cracking of heavy oils, where it is expedient to dilute them with gaseous hydrocarbons or stell. This allows the yield of coke to be decreased and at the same time increases the yield of the liquid fractions. We note that the use of gaseous solvents in the chemical destruction of heavy oils has been widely adopted [1, 6, 7].

It appears that rapid cracking of heavy petroleum products is best accomplished at temperatures of the order of 700 degrees and with a contact time of 0.1 second. It is therefore necessary to heat the crude material very rapidly and cool the products of cracking very rapidly in order to maintain the intended in a special installation with a moving heat carrier on three types of heavy crude materials whose characteristics are given in Table 1 (with recirculation in Table 3. As seen in Table 3 the distillates obtained are listed large amount of unsaturated and sulfur compounds; as a result of reforming these distillates under the conditions of the aromatization process, a high-velocity cracking is best subjected to hydrogenation over a stationary catalyst.



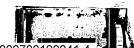
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Table 1. Physicochemical Properties of the Initial Crude Material

								Frac	tional	Comp in	% by	Wt	-
Crude	d.20			al Comp by Wt		% Asphel-	Excise	Initial Boiling		350-			
Material	4_	_C_	_H_	<u>s</u>	_N_	tenes	Tars	Temp (deg)	350°	400°	400- 425°	425° Losses	
No 1	1.0839	85.2	9.2	3.4	0.54	29.0							
No 2	0.9510	85.5	11.4	2.4	0.50	7.0	65.0	150	10.5	8.5	75.0	76.0	
No 3	0.8967			1.77		0.41	20.0	310	11.6	44.7	39.7	3.0 1.0	

Table 2. High-Velocity Cracking With a Heat Carrier

	Temp in Degrees							i in Wt le Mate			
Crude Mate- risl	of the end of Boiling of Fractions Being Taken off	Temp of Added Heat Carrier (deg)	Temp at Center of Reactor (deg)	Reaction time (sec)	Coef of Recir-	Amount of Circulat- ing Gas in % of Load	Fractic Boiling Below 2050		Coke	Gas and Losses	
No 1	205	915	670	0.13	2.0	13.8	28	_	31	41	
No 2	360	900	700	0.10	2.0	13.8	29	48	6.2	16.8	
No 3	205	930	690	0.12	3.0	18.0	61	-	5	34	_



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Table 3. Properties of Distillates of High-Velocity Cracking

								_				
Fractions	d20	Material Sulfo- nizable	No 1 Iodine No by Margoshes' Method	 % s	d ²⁰	Frude Mater # Sulfo- nizable	ial No 2 Todine No by Margoshes' Method			% Sulfo-	erial No 3 Iodine No by Margoshes	
•					_	********	Method	<u>% s</u>	4	<u>nizable</u>	Method	<u> 96 €</u>
With end of boili at 2050	ing 0:7869	91 . 9	198.3	0.8	0.801	2 36.0	173	0.5	0.7984	95.0	143.0	
Boiling at 205-									0.170	97.0	143.0	0.5
360° Boiling	0.9311	89.0	58.1		0.916	68.0	41	1.2	0.9244	76.0	44.7	1.7
above 360°	1.0613			3.8	1.050	- ,-		2.4	1.021			



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